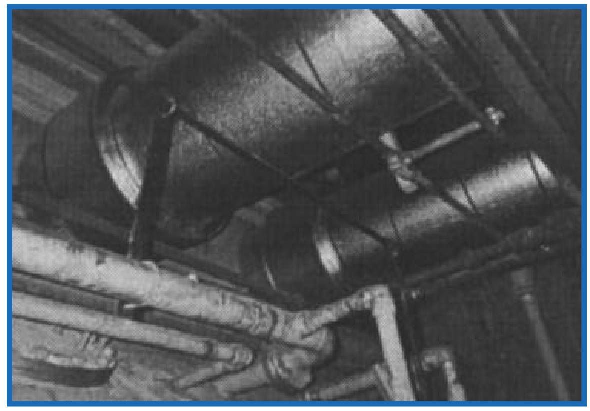
TURNING POINT

September 1998

Steam Challenge—Bethlehem Steel Saves Money by Improving Steam Turbine Performance



Low-pressure steam line.

Steel producers across the country are being forced to improve the efficiency and competitiveness of their steel making operations to stay in business. Bethlehem Steel Corporation's Burns Harbor facility exemplifies how a steel mill can save nearly $3.3 million a year and improve competitiveness by optimizing the performance of just one steam turbine.

Steel making requires a tremendous amount of electricity, most of which Burns Harbor generates from six on-site steam turbines. The steam for these turbines is generated in boilers fueled mostly with coke oven and blast furnace by-product gases. Before the upgrade, Burns Harbor did not have sufficient capacity to consume all the blast furnace gas during an outage of one of the turbine generators. Therefore, the hot gases were essentially wasted, and Burns Harbor had to buy power instead, thereby incurring substantial demand and energy charges.

Burns Harbor considered many options, but redesigning and upgrading turbine #5 was the option that best met the need for increased generation capacity. During the redesign, the project team optimized nozzle and bucket areas to better direct and capture the steam's available energy. They also installed additional throttle valve and nozzles to the existing valve rack and removed second-stage buckets and diaphragms. The turbine was also modified to allow the injection of low-pressure steam.

Another system modification involved changing the source of the boiler feedwater make-up from cold lake water to 20°F warmer condenser cooling water exhaust. This allowed the low-pressure steam that was originally used to heat the lake water to be injected into the modified turbine to produce additional power.

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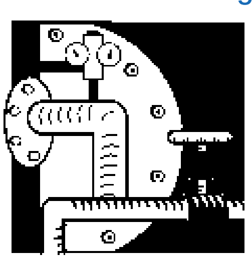
Motor Challenge Information Clearinghouse Takes on Another Challenge



STEAM CHALLENGE

One Challenge wasn't enough. Effective October 1, 1998, the Motor Challenge Information Clearinghouse is expanding to provide services on Steam Challenge. Steam Challenge is a public/private initiative between DOE and the Alliance to Save Energy to promote the comprehensive upgrade of industrial steam systems. Callers will receive the same exceptional service on Steam Challenge as they have on Motor Challenge for the last several years. Call (800) 862-2086 for help on either Motor or Steam Challenge.

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In This Issue

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International Trip Uncovers Synergies with OIT

The English language, customs, and a historical connection are not all we share with the United Kingdom (UK), as Motor Challenge Program Manager Paul Scheihing discovered on his recent trip there. Both of our governments share a common mission to promote greater energy efficiency within their countries. In June, Program Manager Scheihing visited the UK's Energy Technology Support Unit (ETSU)—the principal organization that delivers the UK's government-sponsored, applied, energy efficiency programs to the transportation, commercial, residential, and manufacturing sectors. It was there that Mr. Scheihing noticed similarities between his organization, the U.S. DOE's Office of Industrial Technologies (OIT), and ETSU. ETSU, with a staff of more than 50, focuses on specific industries and works on cross-cutting technologies similar to OIT's programs. But like our pronunciation of the English language, the stress is in a slightly different place. ETSU is devoted to applied technology and does not work in R&D.

"There are valuable opportunities for ETSU and OIT to cooperate on projects and learn from each other's successes," explains Mr. Scheihing. For example, OIT is undertaking activities with its industry partners through the Industries of the Future and programs such as Motor Challenge, Steam Challenge, Compressed Air Challenge, and the Industrial Assessment Centers that are unfamiliar to ETSU. In contrast, ETSU has decades of experience in developing technology-specific, best practices application guides.

In addition to publications, practical guides, and case studies, ETSU has developed several energy management workshops. These workshops, one of which is structured like a game show, aim to involve plant personnel in developing innovative strategies on energy management.

"My presentation sparked constructive discussions of how we can work together. I provided a lot of materials on OIT and left with some ideas on areas in which we could coordinate," states Mr. Scheihing.

Examples of potential areas of cooperation include:

- Formalizing and expanding cooperation with ETSU's Best Practice Programme, including exchange of information and resources.
- Sharing OIT's experience and activities with the Hydraulic Institute (a trade association of pump manufacturers) with ETSU, which will be developing pump systems products and tools.
- Developing a UK *MotorMaster+* software package.
- Adapting each other's materials for use in our respective countries.
- Sharing the experience of the U.S. Compressed Air Challenge, since ETSU is beginning to cooperate with the British Compressed Air Society.

Motor Challenge Member Elected as Vice Chair

Julia Oliver, a member of DOE's Motor Challenge Management team, was recently elected to serve as Vice Chair of the American Water Works Association's Energy Management Committee within the Distribution Plant and Operations Division. The election took place on June 22 in Dallas, Texas, at the national annual meeting. The association has over 54,000 members from the water supply industry. Members are located across the country and internationally.

Guest Column

Bearing Currents: A Major Source of Mechanical Failure for Motors in Adjustable Speed Drive Applications

By Annette von Jouanne, Ph.D., P.E.; Haoran Zhang, Ph.D. Candidate
Oregon State University, Corvallis, OR

Annette von Jouanne

In the past 20 years, industrial controls have experienced dramatic changes with advances in adjustable speed drive (ASD) technology. The introduction of the fast switching semiconductor devices, such as the insulated gate bipolar transistors (IGBT), into pulse-width modulation (PWM) inverter manufacturing has further improved the performance of PWM ASDs. However, shaft voltage and bearing current problems have resurfaced due to the inherently generated common-mode voltage, high-switching frequency, and high dv/dt created by fast switching. Reported premature bearing failures have increased in number and attracted the attention of motor and drive manufacturers and their customers once again.

Causes of bearing currents and bearing failures for motors in PWM ASD operations

Besides magnetic dissymmetries, other causes exist for bearing currents, such as voltage potential accidentally applied to the shaft, electrostatic charge accumulation, and common-mode voltages (voltage potentials relative to a common reference point or ground) generated by unbalanced excitation of the motor windings. Any of the above could cause bearing currents and bearing failures. Recently, common-mode voltages with high frequency and high dv/dt have been a major cause of bearing currents and premature bearing failures in high-frequency, PWM, inverter-fed, induction motors. Modern PWM inverters inherently generate alternating common-mode voltages within the motor windings that cause electrostatic (capacitive) coupling between the rotor and stator windings and frame. This situation enables voltage to build up on the motor shaft.

Since the grease inside the bearings has a partial insulting effect when the motor is running at high speeds, the bearing balls are not in electrical contact with the inner and outer race. Therefore, the charge accumulates on the rotor assembly until it exceeds the dielectric capability of the bearing grease.

The result is a frequently repeated flash-over current up to several hundred milliamps to several amps in magnitude, depending on the motor and the drive. This current, in time, can damage the bearing surfaces due to the electric discharge machining (EDM) effect, or electroplating of the race steel and bearing balls (pitting). Deterioration will appear as fluting (grooves) in the bearing race for motors running at relatively constant speeds, and as frosting on the race surfaces for motors operating over a wide speed range. The first signs of deterioration will be noisy bearings as the bearing friction increases and liberates wearing metal particles into the lubricant. This can lead to bearing destruction within a few months of ASD operation and is expensive in motor repair and downtime. Motor reliability statistics show that bearing failures account for 40% of the total motor failures; almost 25% of bearing failures were from high-frequency switching and high dv/dt.

Although common-mode voltage is inherent in conventional PWM inverters, it is possible to mitigate shaft voltages and/or bearing currents by:

Using a shaft-grounding device to bypass bearing currents

The shaft-grounding device provides a low impedance parallel path from the motor shaft to the frame, which successfully eliminates the shaft voltage and therefore the bearing currents. The grounding brush is self contained for clean room environments. The brush typically requires maintenance in 2-3 years, but is a reliable and comparably low-cost means of protecting the motor bearings. The grounding device can be retrofitted to virtually any motor shaft and is currently on the market.

Isolating the shaft from the motor frame

Isolating the shaft eliminates the current path through the bearings and thus offers protection. This method may not be acceptable if the motor drives loads with their own bearings or if a tachometer is being used, since the shaft voltage still exists and could find another damaging path to ground.

Isolation of the shaft from the frame may be accomplished by using ceramic bearings (a combination of non-magnetic and electrically insulating ceramic balls and bearing quality steel rings). At this time, motors ordered with ceramic bearings will be expensive with long lead times.

Insulating both journals or bearings (i.e., with a resin coating) can prevent the bearing currents to flow. The user can request that journal or bearings are insulated during the manufacturing process, but the cost typically precludes this application for motors less than 200 hp.

Using conducting grease to provide a low impedance path

Conducting grease provides low impedance paths between the bearing balls and bearing races to eliminate the partial insulating effect. Therefore, the shaft voltage is prevented from building up. Unfortunately, a grease with enough conduction contains wearing-conducting elements that can damage the motor bearings.

Building motors with Faraday shields

Some motor manufacturers have experimented and suggest building motors with a Faraday shield inserted into the air gap. The Faraday shield blocks the electrostatic coupling between the stator and the rotor and thus prevents the shaft voltage from building up. Test results show that shaft voltages have been reduced by 98%. However, motors with Faraday shields are not yet commercially available.

Using specially designed inverters

Another solution is to eliminate the problem at the source, i.e., the ASD. This suggests that inverters should be designed such that they do not generate common-mode voltages. A dual-bridge inverter (DBI) has been designed by the authors to generate balanced excitation of the induction motor, so it does not generate common-mode voltages. Experimental results show that the shaft voltages and bearing currents are virtually eliminated.

(continued on page 7)

Mining Industry and DOE Develop Technology Roadmap Into 21st Century

On June 4, 1998, former Secretary of Energy Federico Peña and officials from the National Mining Association penned an agreement to launch an important new government/industry research and development partnership in the mining area.

"Today's agreement will help to maintain the United States as a world leader in mining, reduce costs for producing goods, increase our energy security, improve environmental performance, and help our economy prosper," explains former Secretary Peña. In signing up as one of the department's "Industries of the Future," the mining industry joins a group of seven other energy-intensive industries—aluminum, chemicals, forest products, glass, metalcasting, steel, and agriculture—that are rethinking how they manage technology.

The new compact will lay the groundwork for a broadly agreed upon technology roadmap that should address the needs of the whole industry. The roadmap will enable the industry to begin sharing ideas with an unprecedented unanimity of purpose that should benefit all its members—both coal and hard rock mineral as well as large and small companies. It will enable the mining industry to better inform government and university researchers about the industry's problems so that the researchers can fine-tune their activities.

The mining industry's continued vitality is crucial to the U.S. economy—mining supplies the minerals and coal essential to the competitiveness and supporting infrastructure of virtually the entire U.S. economy. Buildings, bridges, and large and small equipment are all manufactured from processed mineral materials such as glass, ceramics, metals, and cement. Over 70% of the nation's electricity is generated from coal or uranium.

To remain competitive, the mining industry must develop and deploy new technologies to improve environmental performance and meet increased competition from abroad. Indeed, if it is to continue to survive and prosper in the future while meeting the needs of its huge U.S. customer base, the mining industry recognizes that its members need to collaborate and leverage their technological assets with government agencies and national laboratories.

Philadelphia Hosts Successful Motor Challenge Teleconference

The recent May 1998 Motor Challenge teleconference showed how effectively several organizations could work together to host a successful event on efficient motor systems. The U.S. DOE's Philadelphia Regional Support Office, in conjunction with the Pennsylvania Department of Environmental Protection, PECO Energy Company, Atlantic Energy, and Siemens Energy and Automation, hosted the *Efficient Motor Systems II: Your Path to Profits* teleconference in Philadelphia, Pennsylvania, on May 19, 1998. Approximately 35 individuals from industry, utilities, and consulting and nonprofit organizations attended. The morning session consisted of a panel of experts in efficient motor systems from DuPont Engineering, Siemens Energy & Automation, and Rutgers University's Industrial Assessment Center Field Office. The panelists discussed various topics including the "Impact of the Energy Policy Act (EPACT) on Customers Purchasing New Motors," "Effective Motor System Applications," and "Energy Savings from Use with Variable Frequency Drives." Afterwards, the presenters responded to the audience's questions.

The afternoon session featured the teleconference broadcast of *Efficient Motor Systems II: Your Path to Profits,* in which the attendees viewed cases studies on improving reliability, process control, productivity, margins, and profitability. The teleconference also presented techniques on how to sell energy-efficient projects to management.

The one-day event provided an opportunity for attendees to learn about other technical and financial opportunities available through the Office of Industrial Technologies and to receive a demonstration of the energy management software, *MotorMaster+.*

Bethlehem Steel Improves Performance

continued from page 1

These actions accomplished three project objectives:

- to increase the turbine's efficiency and output during normal operations.
- to increase the full-load capacity when other turbines were not in use. (When one of the turbines is experiencing an outage, some of the excess steam is piped to the upgraded turbine, which can now generate as much as 59 MW.)
- to make available and utilize low-pressure steam.

The project cost was $3.4 million more than the scheduled standard maintenance overhaul. With cost savings of $3.3 million annually, the payback is just over one year.

Savings Table

Electricity Savings	*40,000 MWh*
Natural Gas Savings	*85,000 MMBtu*
Annual Cost Savings	*$3.3 million*
Savings Breakdown:	
Reduced demand charges: $1.45 million	
Efficiency gains: $1.3 million	
Avoided temporary power costs from downed turbines: $270,000	
Reduced natural gas costs: $280,000	

Burns Harbor is not the only facility that can reap the benefits of a project like this. The technology could be applied to almost any industrial setting where steam turbines are used for shaft power or to generate electricity on site. Next time your turbine is scheduled for an overhaul, discuss upgrades with your vendor to improve system performance.

Individuals from industry, utilities, and consulting and nonprofit organizations listen intently at Philadelphia's successful Motor Challenge Teleconference.

Performance Optimization Tips

The following article is a regular Turning Point *feature, authored by Don Casada, on motor system performance optimization.*

Recognizing Change Can Help You with Your Motor Systems

by Don Casada, Motor Challenge Program, Oak Ridge National Lab, Oak Ridge, Tennessee

Come gather 'round people
Wherever you roam
And admit that the waters
Around you have grown
And accept it that soon
You'll be drenched to the bone.
If your time to you
Is worth savin'
Then you better start swimmin'
Or you'll sink like a stone
For the times they are a changin'.

These somewhat famous lines, penned by Bob Dylan a generation ago, seem to have an even keener edge in today's world than they did then. An individual in the first American generation observed "Our Constitution is in actual operation; everything appears to promise that it will last, but in this world nothing is certain but death and taxes." (Benjamin Franklin)

Ironically, change is a constant, and it permeates most facets of our lives.

Passing from the poetic to the practical, the ubiquity of change has several consequences for motor systems. This is particularly true for systems involving centrifugal loads, such as pumps and fans. The periods over which changes occur range from seconds (or less) to decades. Generally speaking, simply recognizing change and its potential consequences is the first and most important step. The response to change may range from doing nothing to significantly modifying the system design or operation.

Pumps and fans are designed to operate optimally at a particular flow rate (and corresponding head) condition. When operated at flow rates that are quite different from this design point, the pump or fan efficiency, and in many cases long-term reliability, is reduced. A pair of Motor Challenge Showcase Demonstration projects involved analysis of the range of flow requirements for the wastewater plants in the Town of Trumbull and City of Milford, Connecticut. These projects showed how recognizing a change in condition can result in big cost savings. ITT Flygt and the station operators demonstrated that significant operational savings could be achieved through the addition of smaller pumps that were more appropriately sized for the normal operational points rather than the occasional high flow condition. The underlying condition that created this opportunity was change—in this case, periodic change that had always existed.

In these showcases, the changing condition generally repeats over some time period—for example, daily or annually, or during rainy spells. But other, non-periodic changes, such as those associated with pipe wall scale buildup or changes in production are also important to recognize.

For example, a 3700-gpm, 292-foot head pump was selected for use at the Y-12 Plant in Oak Ridge, Tennessee. For the first few years, the system operated near this design condition. But over time, certain processes shut down, and the system flow rate requirements dropped to around 1200 gpm. The original pump was capable of handling the reduced flow rate, but it was certainly not optimal. By slowing the pump down (using a slower speed motor), and thereby causing the pump to operate nearer its new, low-speed design point, annual savings of $50,000 are accruing. Again, change—in this case non-repetitive in nature—created the opportunity.

Avoidance of change is part of our nature; we tend to be more comfortable with the routine. But that very nature can contribute to inefficiencies, particularly when externally imposed change has occurred and we have avoided a response.

For those involved in facility operations who are interested in energy (and the often accompanying reliability) savings, it may be that a change in nature is in order. A great place to "start swimmin'" is to find those places where "the waters around you have grown" and jump in!

Hydraulic Institute Looks at Life Cycle Costs

The recently formed Life Cycle Cost Committee of the Hydraulic Institute (HI), an association of pump manufacturers and a Motor Challenge Partner, held its second meeting in late July in Sonoma, California. At the committee's request, Motor Challenge is working closely with HI Committee members to develop methods, tools, and reference materials for calculating the life cycle costs of pumping systems.

Meeting participants identified inputs into a life cycle model and will be seeking input from industrial associations and organizations on how to apply the model within their industries. The group reviewed existing software tools for life cycle cost analysis and discussed features that the HI life cycle cost model should possess. A primary focus of the group is coordination of the model with a similar program under development by EUROPUMP, a European pump manufacturers trade association.

The committee plans to meet again in September to prepare for an October meeting with members of EUROPUMP.

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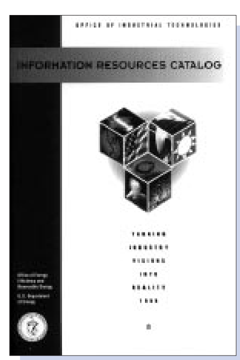

Root Cause Failure Analysis on AC Induction Motors

By John M. Machelor
Motor/Drives Systems Specialist, Motor Challenge Program,
MACRO International Inc.

This is the second in a series of articles by Mr. Machelor. In the July 1998 issue, John addressed the concept of Root Cause Failure Analysis (RCFA) and its dependency on a company's familiarity with its motors and motor systems. This article focuses on common electrical failure modes of in-service induction motors and how to identify their root causes. The discussion is limited to motors powered from the "line" supply (constant voltage and hertz), because powering an induction motor from an ASD introduces a number of unique failure modes. For a discussion on bearing failures for motors in ASD applications, refer to the Guest Column on page 3.

It is common in RCFA to look for root causes first in the application and then, if none are found, to work backward through the motor's history. The reason to start with the application is that the majority of root causes of premature motor failures stem from motor misapplications.

The most common mode of electrical failure of a running induction motor is insulation breakdown in the stator. There are three types of these breakdowns (or "shorts"): (1) phase to phase, (2) phase to ground, or (3) an entire winding failure or "roast out."

Keep in mind that a motor insulation system's biggest enemy is **heat.** A good "rule of thumb" is that for every 10°C increase in temperature to which an insulation system is exposed, its life will be halved. So, what are the root causes that result in a running motor overheating? Below are some of the most common ones.

Motor Overloading: As an induction motor's load is increased, its current (ampere) draw from the line supply increases proportionately. Motor losses that are dependent on current increase as the square of the current, causing an increase in the motor's temperature (heating). Concurrently, the motor's cooling capability is being reduced. For example, Figure 1 represents a typical speed-torque curve for a NEMA Design B, 6-pole induction motor. At full load (100% torque), the motor runs at a constant speed (1160 rpm in this example) and is designed so that its cooling capability can handle all of its full-load losses. Thus, the motor reaches a constant running temperature that does not exceed the rated temperature of its insulation system.

However, if the torque load on the motor is increased beyond full-load torque, the motor output torque will match the load torque (following the curve) but at an ever increasing penalty in losses and slower speed. As Figure 1 shows, when the load torque reaches 175% of full load, the motor speed has decreased to 1080 rpm. The motor output torque will continue to match load torque until the load torque equals/exceeds the motor's "breakdown" torque (knee of the curve). At this point, the motor's speed will rapidly decrease to zero and the motor will "lock" (stall). Current draw will increase to six to eight times full-load current, resulting in insulation failure in a matter of minutes.

An overload condition that stalls the motor is rare as well as catastrophic. What is much more common and often goes unnoticed are overloads from full load to breakdown where excessive motor heating leads to premature insulation failure.

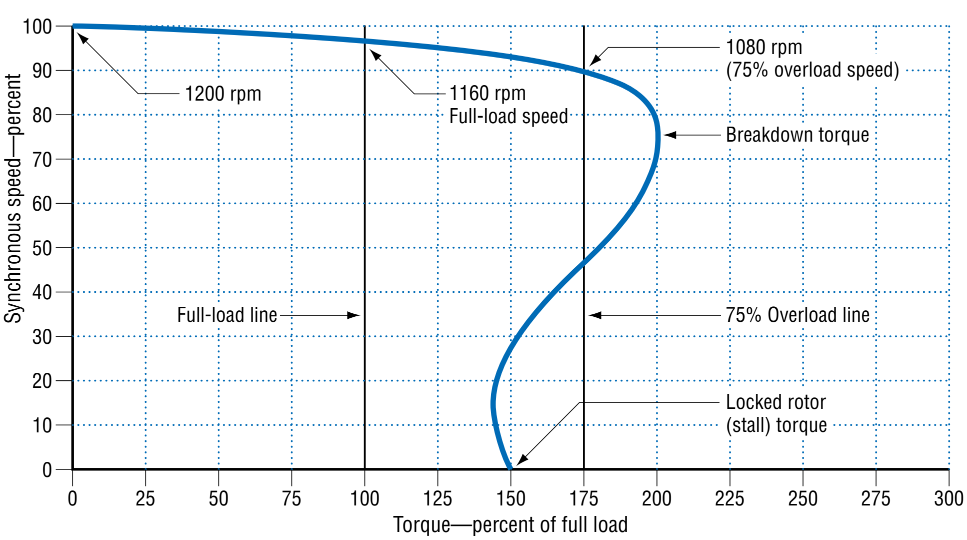

Figure 1. Motor overload effects, John M. Machelor.

Unbalanced Voltages: This is another common root cause of motor overheating. What may seem like a small amount of voltage unbalance may increase the motor's current five to ten times the amount of the voltage unbalance. A 3.5% voltage unbalance will cause an approximate 25% increase in motor temperature rise. Again the culprit is the higher losses associated with the greatly increased and unbalanced currents in the motor's windings. Figure 2 dramatically illustrates the detrimental effects of voltage unbalance. A 5% voltage unbalance causes the motor's horsepower/torque output to be derated nearly 25%!

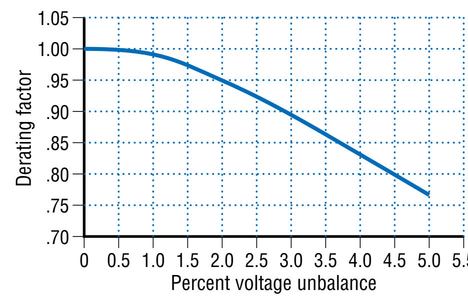

Figure 2. Motor unbalance derating curve, NEMA.

Overvoltage: This root cause condition occurs when the supply voltage is more than 10% greater than the motor rated voltage. It often results in motor overheating from increased "core" or "iron" losses associated with "saturation." A motor's "flux" or "magnetization" level is a function of the volts/hertz supply ratio. If the volts increase while the hertz remains constant, the flux level increases. Depending on a motor design's ability to handle increased flux levels, motors may be pushed into a saturation condition where core losses increase dramatically with resultant motor overheating.

The next article will continue the discussion of root causes of electrical motor failures and then move into mechanical motor failures.

Predictive Maintenance Service

By Rick Latham, Predictive Maintenance Service, Inc.

Predictive Maintenance Service, Inc., of Anderson, South Carolina, is a Motor Challenge Allied Partner that provides companies in the southeast with a total predictive maintenance solution. Many companies are attracted to the efficient and cost effective idea of contracting a predictive maintenance program. By doing so, they avoid capital purchases of test equipment and the lengthy time and expense of training technicians. Ongoing contracts with companies such as BMW, Fuji Photo Film, International Paper, Maxfli, Kaiser Aluminum, Amoco, Frigidiare, Thomas & Betts, Englehard, Lucent Technologies and many more provide exciting and challenging opportunities for Predictive Maintenance Service, Inc.

One customer recently asked Predictive Maintenance Service, Inc., to help answer a question submitted from their corporate headquarters. Headquarters wanted to know why the plant had the most uptime and the least operating cost when compared to similar plants in their division even though they had half the number of maintenance personnel? The first response was simple “Everyone was doing his or her job the way it should be done.” Of course, this answer was not explicit enough and more data was needed.

The data showed that in a period of 3 years the plant had spent approximately $112,000 on a monthly vibration contract, quarterly DC motor inspection, quarterly infrared inspection of the electrical system, and periodic scheduled service calls. Contract maintenance technicians were used on scheduled down-days to supplement the plant’s maintenance force. Outside technicians were used for all major bearing retrofits, roll alignment, laser alignment, and major machine overhauls. One 10-hour monthly shutdown was usually scheduled to perform normal predictive maintenance work orders and to correct items. The predictive maintenance program achieved a total cost avoidance or savings of a little over $2 million.

The most significant savings was found using a combination of predictive maintenance technologies: vibration analysis and oil analysis. The plant has two extruders for coating a thin film of plastic onto paper. One of the extruder gearboxes showed a significant increase in gear mesh vibration over a one-month period. The results of an oil analysis showed a large quantity of water present. The water had entered the oil system through a tube leak in the oil cooler heat exchanger. The heat exchanger was replaced, and the oil was drained from the gearbox. After the gearbox was filled with new oil, a portable filtration cart was hooked up to the gearbox and allowed to run for 2 weeks to remove any remaining water and contaminants. The vibration returned to normal and the gearbox was saved. The second extruder gearbox showed the same problem one month later and was corrected.

Since the plant did not have a spare gearbox and there was a six week lead time on building a new one, these two saves avoided approximately 7 weeks of a total plant shutdown that would have resulted in lost productivity. This is just one example of the power and significance of performing predictive maintenance.

Hawaiian ASD Workshop Exceeds Registration Limit

In the spirit of partnership, distributor HSI Electric, the Hawaiian Electric Company (HECO), the U.S. DOE Motor Challenge Program, and the local Hawaiian DOE representative joined together to put on an informative ASD workshop, held June 19 in Honolulu. This workshop boasted more than 150 registrants and marked the tenth in the series of ASD workshops Motor Challenge has been offering across the nation.

It was hard work and close relationships between cosponsors and customers that generated the initial interest in attending the workshop. A key ingredient to the success of the workshop was a willingness by all parties to work together towards a common goal of bringing valuable knowledge on ASD applications and *ASDMaster* software to those who will use it on the job. Attendees included representatives of end-user companies; federal, state, and local government; utilities; the commercial sector; and ASD manufacturers and distributors.

The cosponsors followed up with potential attendees to make sure they did not miss the opportunity to better understand ASD applications and receive an in-depth demonstration of the *ASDMaster* software analysis tool.

In the future, Motor Challenge hopes to discover how attendees of the ASD workshop series are applying their knowledge to their industrial motor systems. Since ASD applications can enhance productivity and overall efficiency, Motor Challenge plans to publicize end-user efforts so a greater understanding of this technology can be held by all.

Guest Column

continued from page 3

Final comments

Bearing current problems are again capturing attention due to the increased number of ASD-related bearing failures. However, the problem can be prevented. Although bearing currents cannot be measured easily without motor modifications, shaft voltage waveforms are usually attainable. If the magnitude of the high frequency motor shaft voltage is below 3 V, which is the approximate threshold voltage for commonly used grease to breakdown, the motor should generally be free of bearing currents. Otherwise, if a motor is suspected to be working under destructive bearing currents or if similarly operated motors have had abnormal bearing failures, one of the presented mitigation techniques should be considered.

Coming Events 1998-99

September 16	Delaware Valley Energy Efficiency Conference (emphasis on energy-efficient lighting and motors for commercial and industrial applications), sponsored by PA Dept. of Environmental Protection and Villanova University; call Jim McTish at (610) 832-6098 or access the Web at www.dep.state.pa.us/dep/deputate/fieldops/se/se.htm.
September 29	*ASDMaster* Training Workshop, cosponsored by Motor Challenge Allied Partner, Green Bay, WI; call Anna Maksimova at (360) 754-1934.
October 1, 6	*ASDMaster* Training Workshops, cosponsored by Motor Challenge Allied Partners. In Cleveland, OH (Oct. 1); Wausau, WI (Oct. 6). Call Anna Maksimova at (360) 754-1934.
October 28-31	Pump Users Expo 98, Cincinnati, OH; access www.pump-zone.com/meetings/expohome.html or call (818) 885-6279.
October 19, 27, 29	*ASDMaster* Training Workshops, cosponsored by Motor Challenge Allied Partners. In Cincinnati, OH (Oct. 19); Montpelier, VT (Oct. 27); and Oklahoma City, OK (Oct. 29). Call Anna Maksimova at (360) 754-1934.
November 5	How to Get the Most Out of Electric Motor Systems, Prescott, AZ, AZ Department of Commerce; call Gary Graham at (602) 280-1419.
November 8-10	Workshop on Energy Technology Partnerships, Reston, VA; call (540) 231-5182 or access the Web at www.conted.vt.edu/energy/technology.htm.
November 18-19	Greater Philadelphia Plant Engineering and Maintenance Show, King of Prussia, PA. Includes Motor Challenge *MotorMaster+* software demonstraton and an application case study by Southeastern Container. Call (800) 548-1407.
February 7-10	OIT's Third Industrial Energy Efficiency Symposium and Exposition, Washington, DC; call (877) OIT-SYMP.

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INFORMATION CLEARINGHOUSE

Do you have questions about using energy-efficient electric motor systems? Call the Motor Challenge Information Clearinghouse for answers, Monday through Friday 9:00 a.m. to 8:00 p.m. (EST).

HOTLINE: (800) 862-2086

Fax: (360) 586-8303, or access our homepage at www.motor.doe. gov

Understanding Pump Systems Workshops

Morning sessions cover fundamentals required to optimize pump systems; afternoon sessions examine three case studies. Call Anna Maksimova at (360) 754-1934 for more information or to register.

September 22 Little Rock, AR; Arkansas Energy Office
September 29 Erie, PA; PA Department of Environmental Protection
October 3 Orlando, FL; Water Environment Federation Annual Conference

Philadelphia's MotorMaster+ Training

The Philadelphia Regional Support Office will be conducting *MotorMaster+* training for motor users, distributors, and manufacturers who implement the goals of Motor Challenge at the front lines. For further information about *MotorMaster+* training in the Philadelphia region, please contact Maryanne Daniel at (215) 656-6964.

TURNING POINT

The Motor Challenge
EE-20, 5G-067
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